

# Sketchnote summary of “The backscattering story: A personal view”

Robert Dimeo

*Director, NIST Center for Neutron Research, 100 Bureau Drive, MS 6100, Gaithersburg, MD 20899-6100, USA*  
*E-mail: [robert.dimeo@nist.gov](mailto:robert.dimeo@nist.gov)*

**Abstract.** In August 2014, Dr. Anton Heidemann published a short, personal history of the development of neutron backscattering. His fascinating article (<http://tinyurl.com/hahuja4>) described the technical innovations that were made during the development of this technique, and it is supplemented with numerous engaging and endearing anecdotes that give life to this history. This sketchnote summary attempts to capture a flavor of those developments and anecdotes through a series of simple illustrations presented in a sequential visual format. This sketchnote was presented to Dr. Heidemann at the conference “50 Years of Neutron Backscattering” held in Garching September 2–3, 2016.

Keywords: Neutron scattering, neutron spectroscopy, backscattering, sketchnotes

# THE BACKSCATTERING STORY

a PERSONAL VIEW  
ANTON HEIDEMANN

MUNICH  
1965-1970

1966 DIPLOMA

A. HEIDEMANN



1970  
BSS DISMANTLED



FIRST MEASUREMENTS  
V SPECTRUM - 10 DAYS  
S: N ~ 1  
RES - 0.6  $\mu$ eV  
As<sub>2</sub>O<sub>3</sub> - COULDN'T SEE ELASTIC PEAK - WHY?  
V<sub>2</sub>O<sub>3</sub> - INELASTIC SPIN FLIP SCATTERING

ANALYZER  
2000 Si XTALS  
ALIGNED TO <0.1°  
ON A CURVED SUPPORT

BSS INSTRUMENT  
FRM

DISK CHOPPER TO SEPARATE INCIDENT & REFLECTED NEUTRONS



GOOD RELATIONS WITH THE MECHANICAL WORKSHOP!



JÜLICH  
1970-1972

COMMISSIONED  
PI-SPECTROMETER

TRANSPARENT DOPPLER DRIVE

100x FLUX OF MUNICH BSS  
PG XTAL DEFLECTOR  
MULTI ARM ANALYZER



"PI SPECTROMETER?"  
 $2\theta = \pi$  RADS  
 $d_{Si(111)} = \pi \text{ \AA}$   
 $\lambda_{REF} \approx 2\pi \text{ \AA}$

AH CONTINUES RESEARCH ON HYPERFINE INTERACTIONS...

... BUT LEARNED LESSON WHEN TRANSPORTING A CRYOSTAT BY CAR...

LEAKS CAN DEVELOP!



CRYOSTAT FIXED V<sub>2</sub>O<sub>3</sub> MEASURED WITH POLISHED Si XTALS  
⇒ 0.3  $\mu$ eV RESOLUTION!

MORE SUCCESSFUL V<sub>2</sub>O<sub>3</sub> MEASUREMENTS

NEW RESEARCH  
SELF-DIFFUSION IN Na SINGLE X-TAL  
H MOTIONS IN N DOPED Nb  
NH<sub>4</sub> REORIENTATIONS IN NH<sub>4</sub>Cl  
TUNNELING OF CH<sub>3</sub> GROUPS

BACKSCATTERING BROUGHT NEUTRON SCATTERING FROM...

THE → GHz  
... OPENING NEW DOMAINS IN NEUTRON SPECTROSCOPY

MORE BACK

- IN10 B -  
TEMP-SCANNING MONOCHROMATOR

- IN16 -  
HIGH PERF BSS

- IN16 B -  
PERF UPGRADE W/ PST



THE DEVELOPMENT OF A NEW METHOD, WHENEVER ITS PRECISION, SENSITIVITY OR RESOLUTION IS MUCH BETTER THAN EVERYTHING THAT EXISTED IN THIS FIELD BEFORE, CREATES NEW PHYSICS

- MAIER-LEIBNITZ

MANFRED BIRR & A. HEIDEMANN

FRM

HEINZ HAER-LEIBNITZ "HL"

"die Zwillinge" "THE TWINS"

BACKSCATTERING

TAS WITH BRAGG ANGLE  $\theta/2$

**CHALLENGES**

1. LOW INTENSITY  $\rightarrow$  ANALYZER WITH LARGE SOLID ANGLE?
2. HOW TO SEPARATE INCIDENT AND REFLECTED BEAM?
3. HOW TO VARY THE ENERGY?

GUIDES

2cm x 2cm

4cm x 4cm

CONVERGING GUIDE

DOPPLER DRIVE

MONOCHROMATOR

1964 DOUBLE X-TAL VERTICAL NEAR BACKSCATTERING GEOMETRY

~40  $n/min$

~ $\mu eV$  RESOLUTION!

GRAVITY EFFECT OBSERVED

$\Delta E (\mu eV)$

BERTHOLD ALEFED "TUTOR"

BACKSCATTERING DIFFRACTOMETER WITH MÖSSBAUER DRIVE

MEASURE LATTICE PARAMETER CHANGES IN  $SrTiO_3$  NEAR PHASE TRANSITION

GRENoble & ELSEWHERE 1971 - 2014

BSS AT THE ILL?

AS LONG AS IT'S CHEAP AND JÜLICH PROVIDES THE DOPPLER DRIVE AND A PDP-11 COMPUTER

MÖSSBAUER ILL DIRECTOR

IN10 BUILT IN 2 YEARS 1974 - COMMISSIONED

HYPERFINE SPLITTING IN Co (1975)

$\delta \omega (\mu eV)$

MÖSSBAUER WAS IMPRESSED!

**SCATTERING**

- IN13- THERMAL NEUTRON BSS
- NIST HFBS- 1ST PHASE-SPACE TRANSFORM (PST) CHOPPER ON A BSS
- FRM II SPHERES- HIGH PERF BSS W/PST
- IRIS, OSIRIS (ISIS), EMU (ANSTO), BASIS (SNS), BLOZ DNA (J-PARC)

**SCIENCE ON IN10**

1ST USER EXPERIMENT

POLYMER DYNAMICS - JULIA HIGGINS

AND THE OCCASIONAL EVENT - WATER LEAK FROM MAGNET DURING LIQUID CRYSTAL EXPT.

SEARCH FOR NUCLEAR SPIN WAVES

LIQUID CRYSTALS

HYPERFINE INTERACTIONS

TUNNELING

CH<sub>4</sub>

CH<sub>3</sub>-GROUPS

SUPERFLUID He LINEWIDTH

E

ROTON

$Q(\text{\AA}^{-1})$

SKETCHNOTE: Rob Dimeo SEPT. 02, 2016